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INPUTB

(A THERMAL/STRUCTURAL DATA INTERFACE PROGRAM FOR 2-DIMENSIONAL AND 3-DIMENSIONAL INTERPOLATION)

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Prepared by R. G. Vos

J. W. Straayer, Program Manager

Prepared for

National Aeronautics and Space Administration George C. Marshall Space Flight Center Marshall Space Flight Center, Alabama 35812

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1.0 INTRODUCTION

INPUTB is a program for interpolation in both space (2-dimensional or 3-dimensional) and time. It is based on a linear interpolation scheme using simplex spatial regions (triangles and tetrahedra). INPUTB was developed mainly to provide data interfacing between the output from thermal analyzers and the input to the BOPACE 3-D (Boeing plastic analysis capability for 3-dimensional solids using isoparametric finite elements) program. The INPUTB interpolator is of a quite general nature, however, and could be used effectively for other tasks (with appropriate changes in input/output formats, if necessary).

The INPUTB program utilizes temperature values which are given at some sequence of times for a list of strategically located "thermal nodes." It operates on these values by performing a double interpolation (in time and space) to provide temperature values at another desired sequence of times for a list of "structural nodes." The thermal/structural interface procedure is shown in Figure 1-1.

INPUTB is written in FORTRAN IV and is available on both the IBM 360/370 and the UNIVAC 1108 machines. The program has a core storage requirement of 30K words, and it presently has a capability for handling 1000 structural nodes and 500 thermal nodes.

The INPUTB document consists of three major parts:

PART I Theoretical Manual

PART II User Manual

PART III Programmer Manual

Recognition is due to Curt Whiting for his work in preparation of example problems, and in debugging of the program.

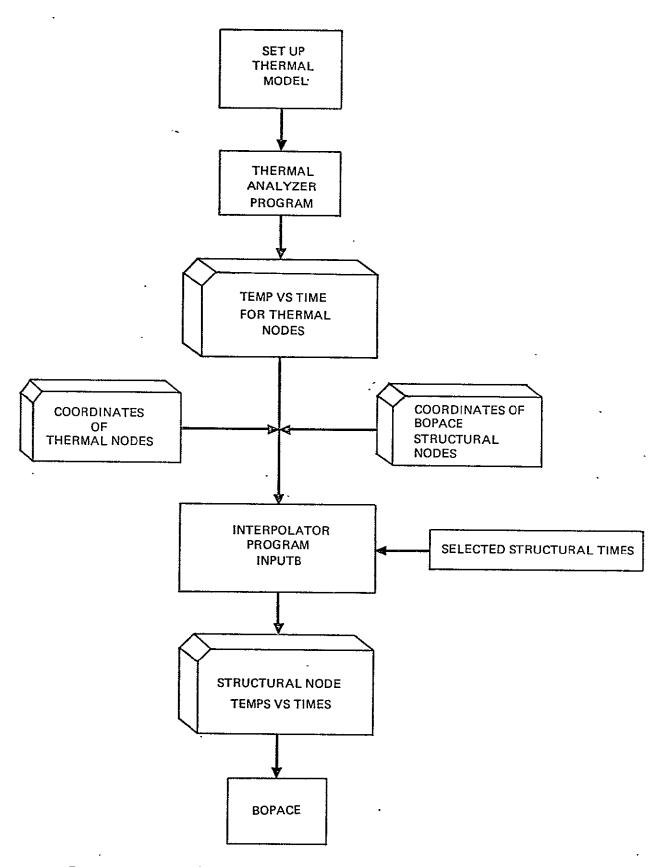


Figure 1-1. Thermal/Structural Interface for INPUTB/BOPACE Run

INPUTB

PART I. THEORETICAL MANUAL

2.0 INPUTB INTERPOLATION THEORY

INPUTB performs a double interpolation in time and space, to convert data associated with one set of times and spatial locations (i.e., thermal node data) to data associated with another set (i.e., structural node data). In order to progressively develop the necessary concepts, the timewise interpolation is discussed first, followed by discussions of the 2-dimensional and 3-dimensional spatial interpolation.

2.1 TIMEWISE INTERPOLATION

The interpolation in time is a simple linear, 1-dimensional scheme. Given the temperature of a point at a sequence of "thermal" times, two of these times are used to compute the temperature at each desired "structural" time. The two thermal times, of course, must be those nearest to the structural time, such that the first is less than or equal to, and the second is greater than or equal to, the structural time.

2.2 SPATIAL 2-DIMENSIONAL INTERPOLATION

The 2-dimensional interpolation scheme is illustrated by Figure 2-1. There the open circles represent thermal nodes with given temperature values, and the closed circle (point N) represents one of the structural nodes at which the temperature must be computed. In general, three thermal node points must be selected (forming an enclosing triangle around the structural node) in order to accomplish an exact linear interpolation. The sequence for selecting these three points is as follows:

- 1. Find point 1 as the thermal node closest to N.
- 2. Locate point 2 as the next closest thermal node such that the smaller angle between lines N-1 and N-2 is greater than 90°. (The restriction on the angle is necessary to avoid possible selection later of the third point such that a long narrow triangle would be formed. Note it also ensures that a

perpendicular from N to the line 1-2 will pass between points 1 and 2).

3. Locate point 3 as the next closest thermal node such that N is enclosed within the triangle 1-2-3. (A necessary and sufficient condition for satisfying this requirement is that the three vector cross products N-1 X N-2, N-2 X N-3, and N-3 X N-1, all have the same direction).

The structural node N divides the triangle into three triangular sub-areas A_1 , A_2 , and A_3 , with total area of the triangle defined by $A = A_1 + A_2 + A_3$. Interpolation weighting factors are then defined by $W_1 = A_1/A$, $W_2 = A_2/A$, and $W_3 = A_3/A$, so that $W_1 + W_2 + W_3 = 1$. Finally, the temperature T_N at point N is computed by

$$T_N = W_1 T_1 + W_2 T_2 + W_3 T_3$$
 (2-1)

where T_i is the temperature of the i th thermal node forming the triangle.

In case a third thermal node is not found to form an enclosing triangle, a perpendicular is defined from N to the line 1-2, intersecting 1-2 at say point N¹. The weights W₁ and W₂ are then computed as the distances from N¹ to points 2 and 1, respectively, divided by the length of line 1-2. T_N can then again be computed from Equation 2-1 (INPUTB logic in this case sets W₃ = 0, and assumes node 3 = node 1). In case a second node is also not found according to the above selection procedure, INPUTB logic sets W₂ = W₃ = 0, and assumes node 2 = node 3 = node 1, and again makes use of Equation 2-1.

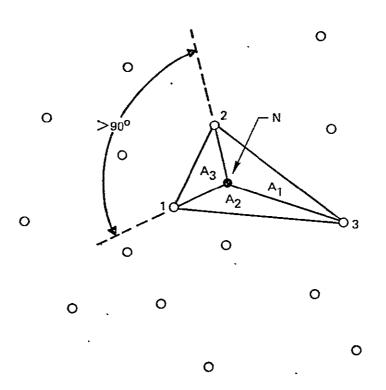


Figure 2-1. 2-Dimensional Spatial Interpolation

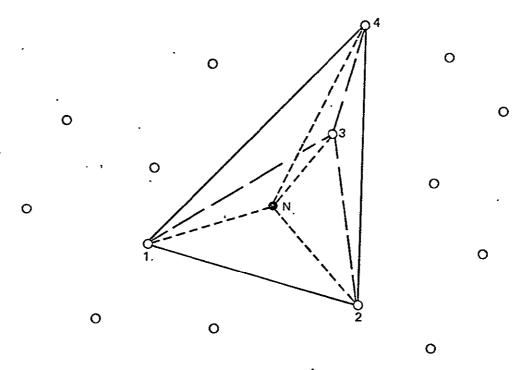


Figure 2-2. 3-Dimensional Spatial Interpolation

2.3 SPATIAL 3-DIMENSIONAL INTERPOLATION

The 3-dimensional interpolation scheme is similar to the 2-dimensional scheme, except that tetrahedra rather than triangles are involved. As shown by Figure 2-2, the open circles again represent thermal nodes with given temperature values, and the closed circle (point N) represents a structural node at which the temperature must be computed.

Four thermal node points must now be selected to form an enclosing tetrahedron around the structural node in order to accomplish an exact linear interpolation. The sequence for selecting these four points is as follows:

- 1. Find point 1 as the thermal node closest to N.
- 2: Locate point 2 as the next closest thermal node such that the smaller angle between lines N-1 and N-2 is greater than 90°.
- 3. Locate point 3 as the next closest thermal node such that a perpendicular from N to the plane 1-2-3 intersects this plane within the triangle 1-2-3. (A vector S is defined normal to the plane 1-2-3. The requirement is satisfied if the three vector dot-cross products S: (N-1 x N-2), S: (N-2 x N-3), and S: (N-3 x N-1), all have the same sign.)
- 4. Locate point 4 as the next closest thermal node such that N is enclosed within the tetrahedron 1-2-3. (A necessary and sufficient condition for satisfying this requirement is that the four vector dot-cross products -N-1·(N-3 x N-4), +N-2·(N-4 x N-1), -N-3·(N-1 x N-2), and +N-4·(N-2 x N-3), all have the same sign.)

The structural node N divides the tetrahedron into four tetrahedral sub-volumes, V_1 , V_2 , V_3 , and V_4 , with total volume of the tetrahedron defined by $V = V_1 + V_2 + V_3 + V_4$ (V_i is the volume of the tetrahedron opposite node point i). Interpolation weighting factors are then defined by $W_1 = V_1/V$, $W_2 = V_2/V$, $W_3 = V_3/V$, and $W_4 = V_4/V$, so that $W_1 + W_2 + W_3 + W_4 = 1$. Finally the temperature T_N at point N is computed by $T_N = W_1 T_1 + W_2 T_2 + W_3 T_3 + W_4 T_4$ (2-2)

where T_i is the temperature of the i th thermal node forming the tetrahedron.

In case a fourth thermal node is not found to form an enclosing tetrahedron, point N is projected perpendicularly onto the 1-2-3 plane, and the 2-dimensional interpolation scheme using triangle 1-2-3 is employed. In case a third or second node is also not found, INPUTB logic again proceeds as discussed for 2-dimensional interpolation.

3.0 PROGRAM FLOW

The major steps accomplished during an INPUTB run are shown in the main program flow summary of Figure 3-1. Step 1 reads input/output file unit number, and allows for printed and/or punched output. READM and READMT read the structural and thermal mesh (node locations) respectively, with structural nodes given in BOPACE 3-D format.

Step 4 reads a series of thermal node temperature vectors, corresponding to a given sequence of times. In step 5, the major interpolation logic is employed, as discussed in Sections 2.2 and 2.3, to select four thermal nodes and compute associated weighting factors, for each structural node. The four nodes and weighting factors are then stored, so that they can later be used to give interpolated structural node temperatures at each desired time. In step 6, the interpolation is actually performed, using these stored values and the thermal node time-temperature vectors read in Step 4. Multiple problems may be executed during a single program run.

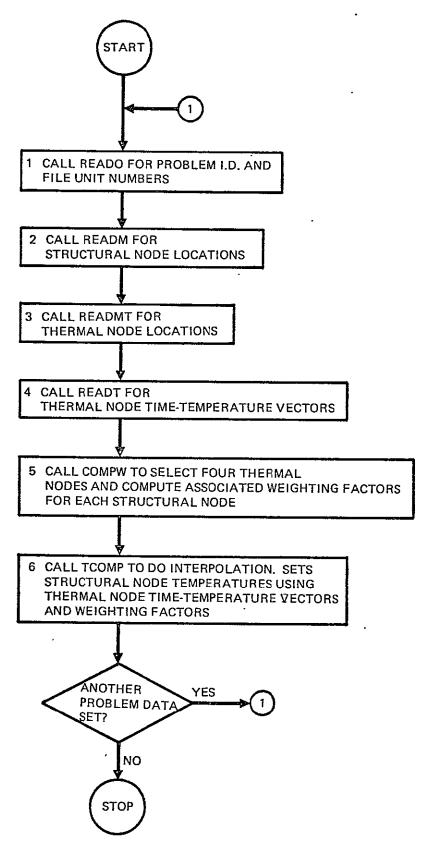


Figure 3-1. Main Problem Flow

INPUTB

PART II. USER MANUAL

4.0 SUMMARY OF INPUT BINPUT DATA

A pictorial of the INPUTB input deck is shown in Figure 4-1. The input data consists of the following two general types.

Type C: Data on the usual card file.

Type 1: Data on File 1. These include almost all of the input data. File 1 is defined by the user so that his data can be input via cards, tape, etc.

The data included on these files are described below. Formats are consistent with FORTRAN IV conventions.

- C-1. Start code and file unit numbers:
 - a. Insert the code "START".
 - b. Unit number for file I. (Must be given).
 - c. Unit number for first output file (e.g., printer). (If not given, this file will not be output.)
 - d. Unit number for second output file (e.g. punch). (If not given, this file will not be output.)

Format (A4, 6X, 315)

- I-1. Problem I.D. title (any 80 characters).
 Format (20A4).
- Structural node location data (BOPACE 3-D format). For each structural node give node I.D. number, identification number of coordinate system to define location (= 0, 1 or 2), coordinates X-Y-Z (or R- Θ -Z or R- Θ - Φ), and

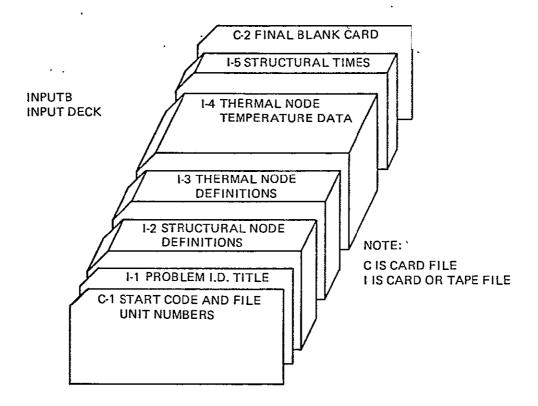


Figure 4-1. INPUTB Input Deck Setup

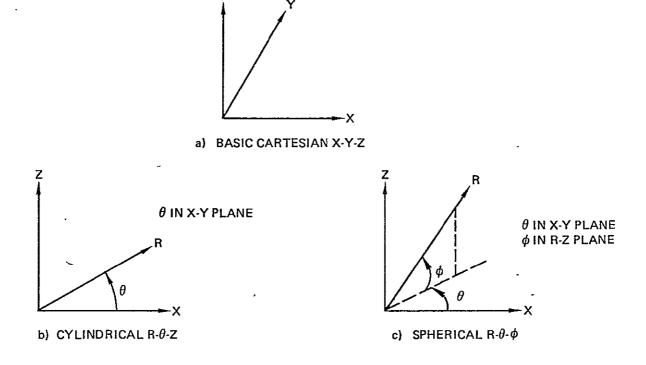


Figure 4-2. Coordinate Systems

identification number of coordinate system to define displacements

(= 0, 1, 2 or other). (Coordinate identification number 0 specifies the basic Cartesian system, 1 specifies the basic spherical system, and 2 specifies a special Cartesian system. Note: The displacement coordinate system I.D. is part of the BOPACE format, but is simply read and printed by INPUTB; also, for a 2-dimensional problem, the third coordinate is input as blank or zero. The basic coordinate systems are illustrated in Figure 4-2.)

Format (215, 3F10.0, 15)

Blank card after last structural node.

I-3. Thermal node location data. For each thermal node give node I.D. number, identification number of coordinate system to define location (= 0, 1 or 2), coordinates X-Y-Z (or R- Θ -Z or R- Θ - $\bar{\Phi}$). (For a 2-dimensional problem, the third coordinate is input as blank or zero.) User has option of one or two thermal nodes per card.

Format (2 (215, 3F10.0))

Blank card after last thermal node.

- 1-4. Thermal node time-temperature data.
 - Number of thermal times (≥2), initial default temperature.
 Format (110, F10.0)
 - b. Time-temperature vectors. For each vector:

Time

Format (F10.0)

Thermal node temperatures. For each node give node 1.D. and temperature.

User has option of from one to four thermal nodes per card.

Format (4(110, F10.0))

Blank card after last value of each vector.

Note: If temperature is not given for any node, it is assigned a value by the program. For the first thermal time, this value is the default temperature in input item I-4. For later times, it is the value from the preceeding time.

1-5. Structural times. Give time value for each time at which interpolated structural temperature output is desired.

Format (F10.0)

After last structural time, insert a card with an integer 9 in column 20.

C-2 Blank card after last problem. (Multiple problem data sets are run consecutively, by stacking each data behind the previous one).

5.0 SUMMARY, OF OUTPUT

The description of INPUTB output is here divided into two parts. The first covers output which is primarily an echo check of the input data and also includes some intermediate calculated results. This output is contained only on the first output file (UOUT1). The second part of the output consists of the final interpolated structural results to be used with BOPACE. This output is contained on both the first and second output files (UOUT1 and UOUT2).

5.1 ECHO CHECK OF INPUT DATA, AND INTERMEDIATE RESULTS

<u>Title</u> - The first page of INPUTB output for a problem contains the 80-character problem I.D. title input as item I-1.

Structural Node Definitions – The information given in input item I-2 is printed. Values are the structural node number, node I.D., location coordinate system number (0 = basic Cartesian, 1 = basic cylindrical, 2 = basic spherical), the location coordinates $(X-Y-Z, R-\Theta-Z, \text{ or } R-\Theta-\Phi)$, and the direction coordinate system number (0 = basic Cartesian, 1 = basic cylindrical, 2 = basic spherical, > 2 = I.D. of special system).

Thermal Node Definitions – The information given in input item 1-3 is printed. Values are the thermal node number, node 1.D., location coordinate system number (0 = basic Cartesian, 1 = basic cylindrical, 2 = basic spherical) and the location coordinates $(X-Y-Z, R-\Theta-Z, \text{ or } R-\Theta-\Phi)$.

Thermal Node Time - Temperature Vectors - The information given in input item I-4 is printed. First the number of thermal times (temperature vectors) is printed, along with the initial default temperature. Then for each given thermal time is printed the time value, followed by the list of node I.D.'s and associated temperature values for each specified node.

Intermediate Interpolation Results – This output is provided for the user so that he may review, if desired, the thermal nodes and corresponding interpolation weighting factors which are associated with each structural node. Values printed are the structural node I.D., and associated four thermal node point I.D.'s and corresponding weighting factors. If only three thermal nodes were used to interpolate temperatures for a particular structural node, then the fourth weight is printed as zero and the fourth thermal node point is printed equal to the first. Similarly if only two thermal nodes were used, the third weight is also printed as zero and the third thermal point is also printed equal to the first. If only one thermal point could be used, all weights but the first are printed as zero and all thermal points are printed equal to the first.

5.2 FINAL RESULTS

These are the final interpolated structural temperatures at each specified structural time, and are written onto both the first and second output files, in BOPACE format. For each structural time the time value is printed on the first line or card (with the remainder of the card filled with asterisks to help the user identify the first card). Following this, is the vector of structural node I.D.'s and corresponding temperature values, for all structural nodes. At the end of each vector is printed a blank card as required for direct input to BOPACE.

6.0 SIZE LIMITATIONS

the following variables are used to specify maximum size limitations in INPUTB. The values set for these variables are given in Table 6-1.

NMAX2 = maximum number of structural nodes.

NMAX4 = maximum structural node I.D. number.

NMAX52 = maximum number of thermal nodes.

NMAX54 = maximum thermal node 1.D. number.

NMAX81 = maximum number of thermal node times.

TABLE 6-1: INPUTB MAXIMUM SIZE LIMITATIONS

VARIABLE	VALUE
NMAX2	1,000
NMAX4	5,000
NMAX52	500
NMAX54	2,500
NMAX81	100

7.0 INPUTB ERROR MESSAGES

INPUTB uses the FORTRAN STOP codes described in this section to indicate error conditions which may occur during execution of the program. The following are explanations of the error STOP codes, listed by subroutine in which they occur.

READO 9999

9999	Normal program exit (not an error) caused by reading final blank card after
	all problems are run.
READM	
701	Structural node I.D. exceeds maximum.
702	1.D. of a structural node location coordinate system not equal to 0, 1 or 2.
704	Number of structural nodes exceeds maximum.
7 05	No structural nodes input.
READMT	
801	Thermal node I.D. exceeds maximum.
802	I.D. of a thernal node location coordinate system not equal to 0, 1 or 2.
804	Number of thermal nodes exceeds maximum.
805	No thermal nodes input.
READT	
901	Undefined thermal node I.D. used to specify temperature at a thermal time.
902	Number of thermal times is less than 2 or exceeds maximum.
TCOMP	
1001	Structural time is outside range of thermal times, or times are not in
	increasing order.

8.0 EXAMPLE PROBLEMS

The example problems provided are intended to familiarize the user with the INPUTB program. Two problems are provided, a 2-dimensional problem which introduces INPUTB in a more easily visualized 2-dimensional format, and a 3-dimensional problem which performs essentially the same functions in three dimensions.

8.1 2-DIMENSIONAL PROBLEM

The mesh used in this problem is shown in Figure 8.1-1. The closed circles correspond to the structural nodes and the open circles to the thermal nodes. Temperature values, at TIME = 1.0, were assigned to the thermal nodes using the equation:

$$T = 50x - 100y$$

A listing of temperature values is shown in Table 8.1-1.

Certain precautions were taken in arriving at input data for this example problem, in order to most effectively illustrate the interpolation procedure, and to guarantee that identical results would be obtained on different computer systems in the presence of small roundoff errors. For these reasons it was important that certain thermal points should not coincide exactly with any structural points, and that two thermal nodes and a structural node should not lie on the same line. It was also important that each structural node be enclosed within a triangle formed by three thermal nodes, which, although not always possible, increases the accuracy of the interpolation. Of course, the user running an actual problem needs to be less concerned with precautions such as those described here.

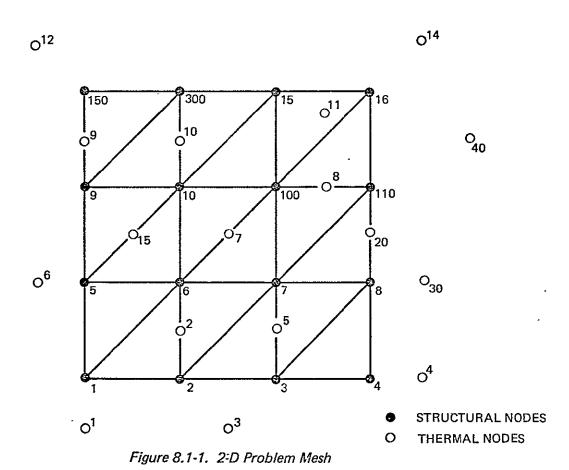


Table 8.1-1. Thermal Node Temperatures for 2-D Problem at Time = 1.0*

Node	Temperature	Node	Temperature
1	50	20	0
2	0	9	-250
3	125	10	-200
4	175	8	75
5	50	1/1	-150
6	-125	40	- 50
7	- 75	12	-325
15	-125	13	-300
30	75	14	-175

*Note: Default Temperature at time 0.0 = 25.0.

```
START
               5
                     6
                          7
INPUTB CHECKOUT PROBLEM (2-D MESH)
                                                                               08/15/75
          0.000
                       0.000
                                  0.000
                                                0
    2
          0 1.000
                       0.000
                                  0.000
                                                0
         0 2.000
    3
                       0.000
                                  0.000
                                                0
         0 3.000
                       0.000
                                  0.000
                                                0
    5
         0 0.000
                       1.000
                                  0.000
                                                0
    6
         0 1.000
                       1.000
                                  0.000
                                                0
    7
         2 2.236
                       26.525
                                  0.000
                                                0
    8
         0 3.000
                       1.000
                                  0.000
                                                0
    9
         0.000
                       2.000
                                  0.000
                                                0
   10
         0 1.000
                       2.000
                                  0.000
                                                0
         0 2.000
  100
                       2.000
                                  0.000
                                                0
  110
         0 3.000
                       2.000
                                  0.000
                                                0
  150
         0.000
                       3.000
                                  0.000
                                                0
  300
         0 1.000
                      3.000
                                 0.000
                                                0
  15
         0 2.000
                      3.000
                                  0.000
                                                0
       . 1 4.242
  16
                      45.000
                                 0.000
                                                0
         0.000
   1
                      -0.500
                                 0.000
                                                2
                                                     0 1.000
                                                                   0.500
                                                                             0.000
   3
         0 1.500
                      -0.500
                                 0.000
                                                4
                                                     0 3.500
                                                                  0.000
                                                                             0.000
   5
         0 2.000
                      0.500
                                 0.000
                                                6
                                                     0 -0:500
                                                                  1.000
                                                                             0.000
   7
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                      1.500
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                                               30
                                                     0 3.500
                                                                  1.000
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  15
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                                 0.000
                                              20
                                                     0 3.000
                                                                  1.500
                                                                             0.000
  40
         0 4.000
                      2.500
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                                               12
                                                     0 - 01500
                                                                  3.500
                                                                             0.000
   8
         0 2.500
                      2.000
                                 0.000
                                               9
                                                     0 0.000
                                                                  2.500
                                                                             0.000
         0 1.000
  10
                      2.500
                                 0.000
                                              11
                                                     0 2.500
                                                                  2.750
                                                                             0.000
  13
         0 2.000
                      4.000
                                 0.000
                                              14
                                                     1 4.950
                                                                  45.000
                                                                             0.000
         2 0.0
0.0
1.0
         1 50.00
                               3 125.00
                                                    4 175.00
                                                                           5 50.00
        6 -125.00
                              7 -75.00
                                                   15 -125.00
                                                                          30 75.00
        9 -250.00
                             10 -200.00
                                                    8 -75.00
                                                                         11 -150.00
       40 -50.00
                             12 -325.00
                                                   13 -300.00
                                                                         14 -175.00
.25
                   0
+50
                   0
1.0
                   0
                   9
```

** NUDE **	LOCATEX				Y3	TSP1-ACE		 	
	0 0.0		0.0	0.0	, ,	0			
1 1 2		0E 01		0.0		0			
4			0.0			()		 	
2 4		0E 01		0.0		C			
5 5	0 0.0		0.10000F 01	0.0		0			
6	0 e.1000	OF 01-	- 0.10000E-01	-().()		(<i>)</i>		 	
7 7	2 0.2234	UE 01	0.265251 02	0.0		0			
8 6	0 0.3000	OF OI	0.10000E 01	$\Theta \bullet \Theta$	•	. 0			
4 9	() () • ()		-0.20000E 01			O		 	
10 10			0.40000E 01			0			
11 100	0 0.2600	OF 61	0.20000E 01	0.0		O .		 	
	0.5001	0t-01 -				· () ·		 	
13 150	0 0.0	116 G.1	0.30000E 01 0.30000F 01			O O			
14 300	000					Č		 	
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1 1 ? ? 3 3	0 0.0 0 0.1000 0.1500 0 0.2500	0E 01'	-0.50000E 00 -0.50000E 00 -0.50000E-00	0.0 0,.0 0.0= 0.0	x3		Q Q		
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8.2 3-DIMENSIONAL PROBLEM

The structural network for this problem consists of three parallel planes, with the structural grids stacked one on top of the other, as shown in Figure 8.2-1. The arrangement of the nodes on each respective plane is shown in Figure 8.2-2. The closed circles correspond to the structural nodes and the open circles to the thermal nodes. The temperature values at TIME = 1.0 were assigned to the thermal nodes using the equation:

$$T = 50 \times -100 \text{y} + 50 \text{z}$$

A listing of the temperature values is shown in Table 8.2-1.

The:same precautions were taken when formulating input data for this example problem as were taken for the 2-dimensional example, with additions being made for a 3-dimensional format.

Thermal nodes were placed on levels .999, 1.999, and 3.001 so that thermal nodes and structural nodes would always be in different horizontal planes. These steps were utilized in order to avoid any inconsistencies in output data due to roundoff on different computer systems.

It was also necessary to try to place the thermal nodes in such a way that each structural node was enclosed within a tetrahedron formed by four thermal nodes. When this condition could not be met the program would substitute the node found for point one in place of the missing points. This case is evident for nodes 12, 13, 30, etc., in the output data.

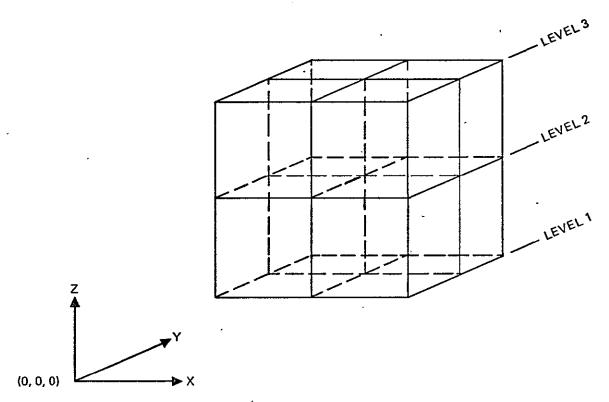


Figure 8.2-1. 3-D Problem Geometry Definition

Table 8.2-1. Thermal Node Temperatures for 3-D Problem at Time = 1.0*

Node	Temperature	Node	Temperature
1	24.95	15	124.95
. 2	25.05	16	-100.10
3	- 75.05	17	75.00
4	0.00	18	~ 75.10
5	62.45	19	- 25.15
6	-124.95	20	-150.00
7	- 75.05	21	175.15
8	-175.15	22	75.05
9	~ 75.15	23	25.05
10	25.50	24	- 50.00
11	174.95	25	50.10
12	175.10	26	-174.95
13	- 0.05	27	-124.95
14	25.0		

^{*}Note: Default temperature at time 0.0 = 0.0.

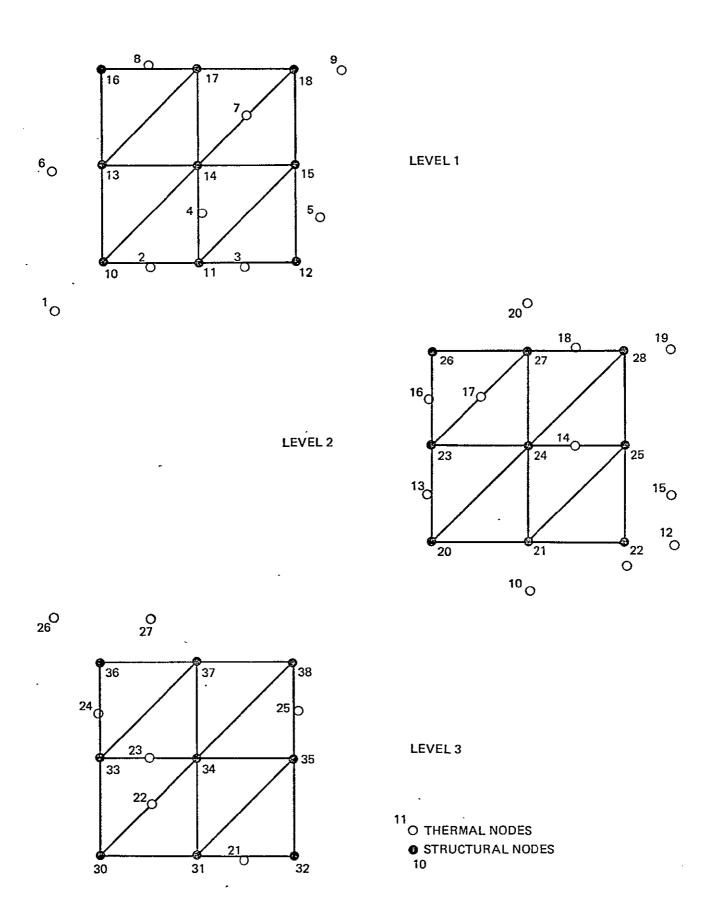


Figure 8.2-2. 3-D Problem Mesh Points

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5	0 3.250	1.500	0.999		6		0.500	1.999	0.999
7	0 2.500	2.500	0.999		8		3.355	63.443	0.999
9	2 4.717	40.611	12.226		10		2.001	0.500	1.999
11	0 3.000	0.750	1.999		12		3.500	0.999	
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17	1 2.915	59.036	1.999		18		2.500	3.001	1.999
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36	74		- 27	16		0 <u>- 54</u> 950	0.0168 0.2505	0. 0	•			S S	
37	27		25	20	0.5544	0.1113		0.00				_ `````````	
38	. 25	13	19	25	0.7996	0.1007	0.3329	0.000	9		<u>•</u>	0 G	
							0.0497	0.0			2,	Y ~~	
		•			*****							<u> </u>	
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	220UF#	***	****	****	*****	·************	عديد والواود والمادار والماد			. —	······································	4	
	10	******** 16.75	***	***** 1 1	**********************	******	****					·	•
	10 14	******** 16.75 6.25	******	TT	31.22	12	30.40	13	-#*** -11 • 76			0 PO 1 PO	4
			******	15	18.75	12 16	30.40 -21.88	13 17.	-8.76 -18.75				
· 		6.25	*****	15 2(31.22 18.75 	12 16 21	30.40 -21.88 24.32	13 17.	-8.76				
ب ماریسید بود مدد.	14 16 23	6.25 6.25- 6.25	******	15 2(24	31.22 18.75 	12 16 21 25	30.40 -21.88 -24.32 31.26	13 17.	-8.76 -18.75			Y	
	14 16	6.25 6.25 -6.25	*****	15 26 24 28	31.22 18.75 	12 16 21 25 30	30.40 -21.98 -24.32 31.26 35.42	13 17. 22	-8.76 -18.75 				
	14 16 25 27 32	6.25 	*****	15 26 24 28 33	31.22 18.75 	12 16 	30.40 -21.88 -24.32 31.26 -55.42	13 17 . 22 20	-8.76 -18.75 -50.04 -5.38 49.10				
	14 16 23 27	6.25 6.25 -6.25	*****	15 26 24 28	31.22 18.75 	12 16 21 25 30	30.40 -21.98 -24.32 31.26 35.42	13 17 . 22 20 31	-8.76 -18.75 				
	14 	6.25 -6.25 -6.25 -6.24 -59.08 -6.25	***	15 26 24 28 33	31.22 18.75 	12 16 	30.40 -21.88 -24.32 31.26 -55.42	13 17 . 22 20 31	-8.76 -18.75 -50.04 -5.38 49.10	,			
	14 	6.25 -6.25 -6.25 -6.24 -59.08 -6.25	****	15 	31.22 18.75 	12 16 	30.40 -21.88 -24.32 31.26 -55.42	13 17 . 22 20 31	-8.76 -18.75 -50.04 -5.38 49.10	,			
	14 	6.25 -6.25 -6.24 -59.08 -6.25	*****	15 -26 24 28 -33 37 *******	31.22 18.75 	12 16 	35.40 -21.98 -24.32 31.26 -55.42 -31.25 26.25	13 17. 22 20 31 35	-8.76 -18.75 -50.04 -5.38 -44.10 -40.69				
	14 	0.25 -6.25 -6.24 -59.08 -6.25 ************************************	*****	15 -26	31.22 18.75 	12 16 21 25 30 34 38 ********	35.40 -21.98 -24.32 31.26 -5.42 -31.25 26.25 ************************************	13 17. 22- 20 31 	-8.76 -18.75 -9.38 -9.10 -40.69 -40.69 -40.69	,	***		
	14 	0.25 -6.25 -6.24 -59.08 -6.25 ************************************	*****	15 -26 24 28 -33 37 *******	31.22 18.75 	12 16 21 	35.40 -21.88 -24.32- -31.26 -5.42 -31.25- -26.25 ************************************	13 17. 22 20 31 35 ********	-8.76 -18.75 -50.04 -5.38 -49.10 -40.59 ********	,	***		
	14 	6.25 -6.25 -6.24 -59.08 -6.25 ************************************	*****	15 -26	31.22 18.75 	12 16 21 25 30 38 ********	35.40 -21.88 -24.32- -31.26 -5.42 -31.25- -26.25 ************************************	13 17. 22 20 31 31 *******	-8.76 -18.75 -50.04 -5.38 -49.10 -40.59 ******** -42.52 -02.51		***		
	14 	6.25 -6.25 -6.24 -59.08 -6.25 ************************************	******	15 -26	31.22 18.75 	12 16 21 25 30 38 *********************************	35.40 -21.88 -24.32- 31.26 -5.42 -31.25- -26.25 ************************************	13 17. 22 20 31 31 35 *******	-8.76 -18.75 -50.04 -5.38 49.10 -40.69 -42.52 -62.51 -75.08 -43.76		***		
	14 16 23 27 36 5000*** 10 14 18 23 27	6.25 6.25 6.25 -6.24 -59.08 -6.25 ************************************	*****	15 -26	31.22 18.75 	12 16 21 25 30 38 ********	35.40 -21.88 -24.32 -31.26 -55.42 -31.25 -26.25 *********** 52.80 -66.77 -23.64 -37.51 45.85	13 17. 22 20 31 35 *********************************	-8.76 -18.75 -50.04 -5.38 49.10 -40.69 -42.52 -62.51 -43.70 73.73				
	14 	6.25 -6.25 -6.24 -59.08 -6.25 ************************************	******	15 -2(18.75 	12 16 21 25 30 38 *********************************	30.40 -21.88 -24.32 -31.26 -55.42 -31.25 -26.25 *********** 52.80 -66.77 -23.64 -37.51 -45.85	13 17. 22 20 31 -35 ******* 13 17 -22 26 31 -35	-8.76 -18.75 -50.04 -5.38 44.10 -40.65 -42.52 -62.51 -75.08 -75.76				
0	14 -16	6.25 -6.25 -6.24 -59.08 -6.25 ************************************	# # 1% 1/4 1/4 -/X	15 -20	31.22 18.75 	12 16 21 25 30 38 ********* 12 16 	35.90 -21.88 -24.32 -31.26 -55.42 -31.25 -26.25 ********** 52.80 -66.77 -23.64 -37.51 45.85 -37.51 -27.49	13 17. 22 20 31 35 ******* 1.3 17 22 26 31	-8.76 -18.75 -50.04 -5.38 -49.10 -40.69 -40.69 -42.52 -62.51 -75.08 -43.70 73.73 -60.77				
0	14 -16	6.25 -6.25 -6.24 -59.08 -6.25 ************************************	# # 1% 1/4 1/4 -/X	15 -20	31.22 18.75 	12 16 21 25 30 38 ********* 12 16 	35.90 -21.88 -24.32 -31.26 -55.42 -31.25 -26.25 ********** 52.80 -66.77 -23.64 -37.51 45.85 -37.51 -27.49	13 17. 22 20 31 35 ******* 1.3 17 22 26 31	-8.76 -18.75 -50.04 -5.38 -49.10 -40.69 -40.69 -42.52 -62.51 -75.08 -43.70 73.73 -60.77				
0	14 -16	6.25 -6.25 -6.24 -59.08 -6.25 ************************************	# # 1% 1/4 1/4 -/X	15 -26	18.75 	12 16 21 30 38 *********************************	35.90 -21.98 -24.32- 31.26 -5.42 -31.25- -26.25 ************************************	13 17. 22 20 31 31 35 ******************************	-8.76 -18.75 -50.04 -5.38 -49.10 -40.59 -40.59 -42.52 -62.51 -75.08 -43.70 73.73 -50.77				
0	14 -16	6.25 -6.25 -6.24 -59.08 -6.25 ************************************	# # 1% 1/4 1/4 -/X	15 -26	11.22 18.75 	12 16 21 25 30 38 ********* 12 16 	35.40 -21.98 -24.32 31.26 -5.42 -31.25 26.25 *********** 52.80 -66.77 -23.64 -37.51 45.85 -37.51 45.85	13 17. 22 20 31 35 ******* 1.3 17 22 26 31	-8.76 -18.75 -50.04 -5.38 -49.10 -40.59 ******** -42.52 -62.51 -75.08 -43.76 73.73 -50.77				
0	14 	6.25 -6.25 -6.24 -59.08 -6.25 ************************************	# # 1% 1/4 1/4 -/X	15 -26	31.22 18.75 	12 16 21 	35.90 -21.98 -24.32 -31.26 -35.42 -31.25 -26.25 ************************************	13 17. 22 20 31 31 35 ******************************	-8.76 -18.75 -50.04 -5.38 -49.10 -40.59 ******** -42.52 -62.51 -75.08 -43.76 73.73 -50.77				
0	14 -16 -23 -27 -36 -36 -10 -18 -23 -27 -37 -36 -36 -10 -18 -18 -18 -18 -18 -18 -18 -18 -18 -18	6.25 -6.25 -6.24 -59.08 -6.25 ************************************	# # 1% 1/4 1/4 -/X	15 -20	31.22 18.75 	12 16 21 30 38 *********************************	35.40 -21.98 -24.32 31.26 -5.42 -31.25 26.25 *********** 52.80 -66.77 -23.64 -37.51 45.85 -37.51 45.85	13 17. 22 20 31 31 35 ******************************	-8.76 -18.75 -5.38 -5.38 -5.10 -40.59 ************************************				
0	14 	6.25 -6.25 -6.24 -59.08 -6.25 ************************************	# # 1% 1/4 1/4 -/X	15 -26	18.75 -70.34 -18.76 6.26 -14.59 0.25 ************************************	12 16 21 	35.90 -21.98 -24.32 -31.26 -35.42 -31.25 -26.25 ************************************	13 17. 22 20 31 31 35 ******************************	-8.76 -18.75 -5.38 -5.38 -5.10 -40.59 ************************************				
0	14 -16	6.25 6.25 6.25 6.25 6.25 6.24 59.08 -6.25 ************************************	# # 1% 1/4 1/4 -/X	15 -26 -24 -28 -33 -37 ****** 11 -20 -24 -28 -33 -37 ******	18.75	12 16 21 25 30 38 ******** 12 16 -21 25 30 36 *********	35.90 -21.98 -24.32 31.26 -55.42 -51.25	13 17. 22 20 31 31 35 ******************************	-8.76 -18.75 -5.38 -5.38 -5.10 -40.59 ************************************				
0	14 -16 -23 -27 -36 5000*** 10 14 -18 -23 -27 -36 -36 -30 -36 -37 -37 -37 -37 -37 -37 -37 -37	6.25 -6.25 -6.24 -59.08 -6.25 ************************************	# # 1% 1/4 1/4 -/X	15 -20	18.75 -70.34 -18.76 6.26 -14.59 0.25 ************************************	12 16 21 25 30 38 ******** 12 16 -21 25 30 36 *********	35.90 -21.98 -24.32 -31.26 -35.42 -31.25 -26.25 ************************************	13 17. 22 20 31 31 35 ******************************	-8.76 -18.75 -5.38 -5.38 -5.10 -40.59 ************************************				

INPUTB .

PART III. PROGRAMMER MANUAL

9.0 SUBROUTINES

All the subroutines of the INPUTB program are described in this section, with their calling sequence and argument variable definitions. The main program is described in Section 3.

9.1 READO

Subroutine READO reads the problem identification card, and the input/output file unit numbers.

Call READO (UIN, UOUT1, UOUT2)

UIN - input file unit number (e.g., cards).

UOUT1 - first output file unit number (e.g., printer).

UOU.T2 - second output file unit number (e.g., punch).

9.2 READM

Subroutine READM reads the structural node locations, using BOPACE 3-D data format.

Call READM (UIN, UOUT1, NOD, COORD, NODE, NMAX2, NMAX4)

UIN - input file unit number.

UOUTI - first output file unit number

NOD - number of structural nodes.

COORD - COORD (J, I) = Jth coordinate of node !..

NODE - NODE (I) = external node I.D. for internal node I.

NMAX2 - maximum number of nodes.

NMAX4 - maximum node I.D. number.

9.3 READMT

Subroutine READMT reads the thermal node locations.

Call READMT (UIN, UOUTI, NO DT, COORDT, NODET, NODIT, NMAX52, NMAX54).

UIN - input file unit number.

UOUT1 - first output file unit number.

NODT - number of thermal nodes.

COORDT - COORDT (J, !) = J th coordinate of node 1.

NODET - NODET (I) = external node 1.D. for internal node 1.

NODIT - NODIT (I) = node internal number for external 1.D. 1.

NMAX52 - maximum number of thermal nodes.

NMAX54 - maximum thermal node I.D. number.

9.4 READT

Subroutine READT reads the vector of thermal node temperatures, at each given thermal time.

Call READT (UIN, UOUTI, 10T, NTIME, TIME, NODT, NODIT, NMAX54, NMAX 81)

UIN - input file unit number

UOUT1 - first output file unit number.

IOT - file unit number for storing thermal node temperature vectors.

NTIME - number of temperature vectors (time values) given for thermal nodes.

TIME - TIME (I) = I th time value for thermal nodes.

NODT - number of thermal nodes.

NODIT - NODIT (I) - node internal number for external I.D. I.

NMAX54 - maximum thermal node 1.D. number.

NMAX81 vije maximum number of thermal node temperature vectors (time values).

9.5 COMPW

Subroutine COMPW selects four thermal nodes and associated weighting factors for each structural node, and stores them for later interpolation.

Call COMPW (UOUT1, NOD, NODT, COORD, COORDT, NON, NOW, NODE, NODET)

UOUT1 - first output file unit number

NOD - number of structural nodes.

NODT - number of thermal nodes.

COORD - COORD (J, 1) - Jth coordinate of structural node 1.

COORDT - COORDT (J, I) = Jth coordinate of thermal node 1.

NON - NON (J, 1) = selected Jth thermal node (J= 1-4) for weighting temperature of structural node 1.

NOW - NOW (J, 1) = computed J the thermal node weight (J = 1-4) for structural node I.

NODE - NODE (I) = external I.D. for internal structural node I.

NODET - NODET (I) = external I.D. for internal thermal node I.

9.6 TCOMP

Subroutine TCOMP performs the actual interpolation in space and time, to compute structural node temperatures, using the thermal node temperature vectors and the weighting factors.

Call TCOMP (UIN, UOUTI, UOUT2, IOT, NOD, NODT, NON, NOW, NTIME, TIME, NODE)

UIN - input file unit number

UOUT1 - first output file unit number.

UOUT2 - second output file unit number.

IOT - file unit number for storing thermal node temperature vectors.

NOD - number of structural nodes.

NODT - number of thermal nodes.

NON - NON (J, I) - Jth thermal node (J = 1-4) for weighting temperature of structural node I.

NOW - NOW (J, I) = J the thermal node weight (J = 1-4) for structural node 1.

NTIME - number of time values (temperature vectors) for thermal nodes.

TIME - TIME (I) = 1 th time value for thermal nodes.

NODE - NODE (I) = external I.D. for internal structural node I.

10.0 COMMON BLOCKS

The only common used in the INPUTB program are the two labeled common blocks

COMTO and COMT1, which provide storage space for thermal node temperature vectors.

Common/COMTO/TO (used in MAIN, TCOMP)

Common/COMT1/T1 (used in MAIN, READT, TCOMP)

The MAIN program contains both TO and T1, and is used to dimension these vectors. Subroutine READT uses the T1 vector as temporary storage to read in each thermal node temperature vector before writing it onto the file IOT. Subroutine TCOMP uses both the TO and T1 vectors, to read and store thermal node temperature vectors from file IOT, at successive thermal time values. These vectors are then used to interpolate all structural node temperatures within the time interval from TO to T1.

11.0 FILE USAGE

INPUTB uses FORTRAN I/O to access several files. Some of the files are defined by the user and the others are defined in the program. A list of files by logical unit number follows:

UNIT NUMBER	DESCRIPTION	DEFINED BY
5	Input card file	READO
UIN	Input data file	user
UOUT1	First output file. Contains all output results, including echo check of input data, and intermediate results.	user
UOUT2	Second output file. Contains only final output results, i.e., interpolated structural node temperature data.	user
IOT (=II)	Storage file for thermal node temperature vectors.	MAIN .



C	********	*****
С	I N P U T B (THERMAL/STRUCTURAL DATA INTERFACE PROGRAM)	00000020
С	INPUTB IBM 360/370 VERSION (1000 NODES) DATED 09/15/75	00000020
C	BUEING AEROSPACE COMPANY, P.O. BOX 3999, SEATTLE, WASH. 98124	00000030
C	ENGINEER/PROGRAMMER: R.G. VOS. PHONE 773-2946. BLDG. 18-05	00000050
С	***************	00000000
C	SPACE-TIME INTERPOLATION FOR 1-, 2- OR 3-DIMENSIONAL SPACES.	
С	PROBLEM SIZE CAPABILITY INCLUDES 1000 STRUCTURAL NODES.	00000070
C	500 THERMAL NODES, 100 THERMAL NODE TIMES, ARBITRARY NUMBER OF	08000000
C	STRUCTURAL NODE TIMES.	00000090
С	MAXIMUM STRUCTURAL, THERMAL NODE I.D. NUMBERS ARE 5000,2500;	00000100
С	NOCES ARE LOCATED IN BASIC CARTESIAN, CYLINDRICAL OR SPHERICAL	00000110
Č	CCORDINATES.	00000120
•	INTEGER UIN, UOUT1, UOUT2, IOT, NOD, NODT, NTIME, NMAX2, NMAX4, NMAX52,	00000130
	INMAX54, NMAX81	00000140
	INTEGER NCDE(1000), NODET(500), NDDIT(2500), NON(4, 1000)	00000150
	REAL TO(500), T1(500), TIME(100), CROPO(2, 1000), COOPERING COOPERING	00000160
	REAL TO(500),T1(500),TIME(100),COORD(3,1000),COORDT(3,500), 1NOW(4,1000)	00000170
	COMMON/COMTO/TO/COMT1/T1	00000180
	DATA IOT/11/	C0000190
		00000200.
С	DATA NMAX2, NMAX4, NMAX52, NMAX54, NMAX81/1000, 5000, 500, 2500, 100/	00000210
C	READ PROBLEM I.D. AND FILE UNIT NUMBERS.	00000220
С	1 CALL READO(UIN, UOUT1, UOUT2)	00000230
C	READ STRUCTURAL NODE DEFINITIONS.	00000240
С	· CALL READM(UIN, UOUT1, NOD, COORD, NODE, NMAX2, NMAX4)	00000250
C	READ THERMAL NODE DEFINITIONS.	00000260
C	CALL READMT(UIN, UOUTL, NODT, COORDT, NODET, NODIT, NMAX52, NMAX54)	00000270
С	READ THERMAL NODE TIME-TEMPERATURE VECTORS.	00000280
_	CALL READT (UIN, UOUT1, LOT, NTIME, TIME, NODT, NODIT, NMAX54, NMAX81)	00000290
C	SELECT THERMAL POINTS AND COMPUTE CORRESPONDING WEIGHTS TO GIVE	00000300
С	STRUCTURAL TEMPERATURES AS FUNCTIONS OF THERMAL NODE TEMPERATURES	.00000310
_	CALL CUMPW(UUUTI,NOD,NODT,COORD,COORDT,NON,NOW,NODE,NODET)	00000320
С	COMPUTE AND OUTPUT STRUCTURAL NODE TEMPERATURES AT GIVEN TIMES.	00000330
	CALL TCOMP(UIN, UOUT1, UOUT2, IOT, NOD, NODT, NON, NOW, NTIME, TIME, NODE)	00000340
	GC TG 1	00000350
	END	00000360
	SUBROUTINE READO(UIN, UOUT1, UOUT2)	00000370
C	READ FILE UNIT NUMBERS AND PROBLEM IDENTIFICATION	00000370
	==	0000000

```
UIN = INPUT FILE UNIT NUMBER.
UUUT1, UUUT2 = OUTPUT FILE UNIT NUMBERS.
C
                                                                                                 00000390
                                                                                                 00000400
        STOP 9999 = NORMAL PROGRAM EXIT AFTER LAST PROBLEM IS INPUT.
                                                                                                 00000410
        INTEGER UIN.UOUT1.UOUT2
       INTEGER UIN, UOUT1, UOUT2
INTEGER I, START, STAR, IDENT(20)
FORMAT(A4, 6X, 315)
FORMAT(20A4)
FORMAT(1H1, 20A4)
DATA STAR/4HSTAR /
READ(5, 101) START, UIN, UOUT1, UOUT2
IF(START, NE. STAR) STOP 9999
READ(UIN, 102) (IDENT(I), I=1, 20)
IF(UOUT1.GT.O) WRITE(UOUT1, 201) (IDENT(I), I=1, 20)
IF(UCUT2.GT.O) WRITE(UOUT2, 102) (IDENT(I), I=1, 20)
RETURN
                                                                                                 00000420
                                                                                                 00000430
   101 FORMAT(A4,6X,315)
                                                                                                 00000440
  102 FORMAT (20A4)
                                                                                                 00000450
  2C1 FORMAT(1H1.20A4)
                                                                                                 000.00460
                                                                                                 00000470
                                                                                                 00000480
                                                                                                 00000490
                                                                                                 00000500
                                                                                                 00000510
                                                                                                 00000520
        RETURN
                                                                                                 00000530
        END
                                                                                                 00000540
        SUBROUTINE READM(UI, UO, NOD, COORD, NODE, NMAX2, NMAX4)
                                                                                                 00000550
        READ STRUCTURAL NODE DATA.
                                                                                                 00000560
       UI, UO = INPUT, GUTPUT FILE UNIT NUMBERS.

NOD = NUMBER OF STRUCTURAL NODE'S.

COORD(J,I) = COORDINATES OF NODE I.
                                                                                                 00000570
                                                                                                 00000580
                                                                                                 00000590
C
       NODE(I) = NODE EXTERNAL I.D. FOR INTERNAL NUMBER I:
                                                                                                 00000600
       NMAX2 = MAXIMUM NUMBER OF NODES.
                                                                                                 00000610
С
        NMAX4 = MAXIMUM NODE I.D. NUMBER.
                                                                                                 00000620
C
       STOP 701 = STRUCTURAL NODE I.D. EXCEEDS MAXIMUM.
                                                                                                 00000630
С
        STOP 702 = I.D. OF A STRUCTURAL NODE LOCATION COORDINATE SYSTEM
                                                                                                 00000640
C
       NOT EQUAL TO 0,1 UR 2.
                                                                                                 00000650
С
       STOP 704 = NUMBER OF STRUCTURAL NODES EXCEEDS MAXIMUM.
                                                                                                 00000660
       STOP 705 = NO STRUCTURAL NODES INPUT. .
                                                                                                 00000670
       INTEGER UI, UO, NOD, NODE(1), NMAX2, NMAX4
REAL COORD(3,1)
INTEGER I, LCOORD, DCOORD
REAL F, ANGLE, X, Y, Z
EGRMAT (215,3510,0,15)
                                                                                                 00000680
                                                                                                 00000690
                                                                                                 00000700
                                                                                                 00000710
  101 FORMAT (215,3F10.0,15)
                                                                                                 00000720
  201 FORMAT(1H1,10H** NUDE **/1H ,18H NO. IID. LOCATE,6X,
                                                                                                00000730
       12HX1,11X,2HX2,11X,2HX3,8X,8HDISPLACE)
                                                                                                00000740
  202 FORMAT(215,2X,15,3X,3(E12.5,1X),1X,15)
                                                                                                00000750
       F = 3.1415927/180.
                                                                                                00000760
```

```
WRITE(UD, 201)
NCD = 0
6 READ(UI, 101)I, LCOORD, X, Y, Z, DCOORD
IF(I.LE: 0)GO TO 150
IF(I.GT.NMAX4)STOP 701
                                                                                                              00000770
                                                                                                              00000780
                                                                                                              00000790
                                                                                                              00000800
                                                                                                              00000810
         IF(LCOORD.NE.O.AND.LCOORD.NE.1.AND.LCOORD.NE.2)STOP 702
                                                                                                              00000820
         NOD = NOD + 1
                                                                                                              00000830
         IF(NGD.GT.NMAX2)STOP 704
                                                                                                              00000840
         IF(UO.GT.O)WRITE(UO,202)NOD,I,LCOORD,X,Y,Z,DCOORD
                                                                                                              00000850
       NODE(NOD) = I
IF(LCOORD.EQ.O)GO TO 12
IF(LCOORD.EQ.1)GO TO 11
SPHERICAL COORDINATES.
ANGLE = Z*F
Z = X*SIN(ANGLE)
X = X*CUS(ANGLE)
CYLINDRICAL CUORDINATES.
ANGLE = Y*F
Y = X*SIN(ANGLE)
X = X*COS(ANGLE)
SASIC CARTESIAN COORDINATES.
COORD(1.NCD) = X
         NODE(NOD) = 1
                                                                                                              00000860
                                                                                                              00000870
                                                                                                              08800000
C
                                                                                                              00000890
                                                                                                              00000900
                                                                                                              00000910
                                                                                                              00000920
C
                                                                                                              00000930
     11 ANGLE = Y*F
                                                                                                              00000940
                                                                                                              00000950
                                                                                                              00000960
C
  00000970
                                                                                                             00000980
                                                                                                             00000990
                                                                                                             00001000
                                                                                                             00001010
                                                                                                             00001020
                                                                                                             00001030
                                                                                                             00001040
         SUBROUTINE READMT(UI, UO, NODT, COORDT, NODET, NODIT, NMAX52, NMAX54)
                                                                                                             00001050
C
         READ THERMAL NODE DATA.
                                                                                                             00001060
        UI, UO = INPUT, OUTPUT FILE UNIT NUMBERS.

NCDT = NUMBER OF THERMAL NODES.

COORDT(J,I) = COORDINATES OF NODE I.
C
                                                                                                             00001070
C
                                                                                                             00001080
C
                                                                                                             00001090
        NODET(I) = NODE EXTERNAL I.D. FOR INTERNAL NUMBER I.

NCDIT(I) = NODE INTERNAL NUMBER FOR EXTERNAL I.D. I.

NMAX52 = MAXIMUM NUMBER OF THERMAL NODES.

NMAX54 = MAXIMUM THERMAL NODE I.D. NUMBER.

STOP 801 = THERMAL NODE I.D. EXCEEDS MAXIMUM.

00001190
00001100
00001110
00001120
00001130
C
C
C
C
```

```
14
```

```
STOP 802 = I.D. OF A THERMAL NODE LOCATION COORDINATE SYSTEM
С
                                                                                  00001150
C
      NET EQUAL TO 0.1 DR 2.
                                                                                  00001160
C
      STOP 804 = NUMBER OF THERMAL NODES EXCEEDS MAXIMUM.
                                                                                  C0001170
       STOP 805 = NO THERMAL NODES INPUT.
                                                                                  00001180
      INTEGER UI, UD, NODT, NODET(1), NODIT(1), NMAX52, NMAX54
                                                                                  00001190
      REAL COORDT (3.1)
                                                                                  00001200
      INTEGER I, LCOORD, K, ISTOR(2), LSTOR(2)
                                                                                  00001210
      REAL F, ANGLE, X, Y, Z, XSTOR(2), YSTOR(2), ZSTOR(2)
                                                                                  00001220
  101 FCRMAT (2(215,3F10,0))
                                                                                  00001230
  201 FORMAT(1H1,10H* T NODE */1H ,18H NO. ILD. LOCATE.6X.
                                                                                  00001240
     12HX1,11X,2HX2,11X,2HX3)
                                                                                  00001250
 202 FORMAT(215,2X,15,3X,3(E12.5,1X))

F = 3.1415927/180.

WRITE(U0,201)

DO 2 I=1,NMAX54

2 NODIT(I) = 0
                                                                                  00001260
                                                                                  00001270
                                                                                  00001280
                                                                                  00001290
                                                                                  00001300
      NODT = 0
                                                                                  00001310
    6 READ(UI, 101)(ISTOR(K), LSTOR(K), XSTOR(K), YSTOR(K), ZSTOR(K), K=1,2)
                                                                                  00001320
     DG 8 K=1,2
IF(ISTOR(K).NE.O)GD TO 9
CONTINUE
IF(NCDT.EG.O)STOP 805
RETURN
DO 20 K=1,2
I = ISTOR(K)
IF(I.LE.O)GO TO 20
IF(I.GT.NMAX54)STOP 801
LCCCRD = LSTOR(K)
      DO 8 K=1.2
                                                                                  00001330
                                                                                 00001340.
    8 CONTINUE
                                                                                 00001350
                                                                                 00001360
                                                                                 00001370
    9 DO 20 K=1.2
                                                                                 00001380
    \cdot I = ISTOR(K)
                                                                                 00001390
                                                                                 00001400
                                                                                 00001410
                                                                                 00001420
      IF(LCOORD.NE.O.AND.LCOORD.NE.1.AND.LCOORD.NE.2)STOP 802
                                                                                 00001430
      NODT = NODT + 1
                                                                                 00001440
      IF(NODT.GT.NMAX52)STOP 804
                                                                                 00001450
      X = XSTOR(K)
                                                                                 00001460
      Y = YSTOR(K)

Z = ZSTOR(K)

IF(UO.GT.O)WRITE(UO,202)NODT, L, LCOORD, X, Y, Z
                                                                                 00001470
                                                                                 00001480
                                                                                 00001490
      NODET(NODT) = I
                                                                                 00001500
      NODIT(I) = NDDT
                                                                                 00001510
      IF(LCGORD.EQ.O)GO TO 12
                                                                                 00001520
      IF(LCOORD.EQ.1)GO TO 11
                                                                                 00001530
      SPHERICAL COORDINATES.
                                                                                 00001540
```

```
ANGLE = Z*F
                                                                                      00001550
                Z = X*SIN(ANGLE)
                                                                                      00001560
                X = X*COS(ANGLE)
                                                                                      00001570
               CYLINDRICAL COORDINATES.
         C
                                                                                      00001580
             11 ANGLE = Y \times F
                                                                                      00001590
                Y = X*SIN(ANGLE)
                                                                                      00001600
Originali page is
Of Poor quality
                X = X*COS(ANGLE)
                                                                                      00001610
                BASIC CARTESIAN COORDINATES.
                                                                                      00001620
           12
               COORDT(1,NODT) = X
                                                                                      00001630
               CCGRDT(2.NODT) = Y
                                                                                      00001640
               COORDT(3, NODT) = Z
                                                                                      00001650
            20 CONTINUE
                                                                                      00001660
               GC TO 6
                                                                                      C0001670
               END
                                                                                      00001680
               SUBROUTINE READT(UI, UO, IOT, NTIME, TIME, NODT, NODIT, NMAX54, NMAX81)
                                                                                      00001690
         С
               READ THERMAL NODE TIME-TEMPERATURE VECTORS.
                                                                                      00001700
         C
               UI, UO = INPUT, OUTPUT FILE UNIT NUMBERS.
                                                                                      00001710
         C
               IOT = FILE UNIT NUMBER FOR THERMAL NODE TIME-TEMPERATURE VECTORS. 00001720
A-5
         C
               NTIME = NUMBER OF TIME VALUES FOR THERMAL NODES:
                                                                                      00001730
         C
               TIME(I) = ITH TIME VALUE FOR THERMAL NODES.
                                                                                      00001740
               NCDT = NUMBER OF THERMAL NODES.
                                                                                      00001750
         С
               NODIT(I) = THERMAL NODE INTERNAL NUMBER FOR EXTERNAL ILD. I.
                                                                                      00001760
               NMAX54 = MAXIMUM THERMAL NODE L.D. NUMBER.
                                                                                      00001770
         С
               NMAX81 = MAXIMUM NUMBER OF THERMAL TIMES.
                                                                                      C0001780
               STOP 901 = UNDEFINED THERMAL NODE I.D. USED TO SPECIFY TEMPERATURE00001790
         С
               STOP 902 = NUMBER OF THERMAL TIMES IS LESS THAN 2 OR EXCEEDS
                                                                                      00001800
         C
               MAXIMUMA
                                                                                      00001810
               COMMON/ COMT1/T1
                                                                                      00001820
         С
               T1(1) = TEMPERATURE OF ITH THERMAL NODE AT GIVEN TIME.
                                                                                      00001830
               INTEGER UI, UO, UOT, NTIME, NODT, NODIT(1), NMAX54, NMAX81
                                                                                      CC001840
               REAL TIME(1), T1(1)
                                                                                      00001850
               INTEGER I, K, ITIME, ISTOR (4)
                                                                                      00001860
               REAL TEMPO, STOR (4)
                                                                                      00001870
           101 FORMAT(110.F10.0)
                                                                                      00001880
           102 FORMAT(F1C.O)
                                                                                      00001890
           103 FORMAT(4(IIO, F10.0))
                                                                                      00001900
           201 FCRMAT(1H1,40HNUMBER OF TIMES (TEMPERATURE VECTORS) = .13.
                                                                                      00001910
              110X,22HDCFAULT TEMPERATURE = ,F10.4)
```

00001920

С

```
202 FORMAT(1H1,30HTEMPERATURE VECTOR FOR TIME = ,E12.4/
11H0,25HTHERMAL PT. TEMPERATURE)
203 FORMAT(1H,15,7X,F12.2)
READ(UI,101)NTIME,TEMPO
IF(UO.GT.0)WRITE(UO,201)NTIME,TEMPO
                                                                                                                00001930
                                                                                                                00001940
                                                                                                                000.01950
      IF(NTIME.LT.2.OR.NTIME.GT.NMAX81)STOP 902
REWIND IOT
DC 100 ITIME=1,NTIME
                                                                                                                00001960
                                                                                                                00001970
 REWIND IOT

DC 100 ITIME=1,NTIME

READ(UI,102)TIME(ITIME) /

IF(U0.GT.0)WRITE(U0,202)TIME(ITIME)

IF(ITIME.GT.1)GO TO 13

DO 5 I=1,NOOT

5 I1(I) = TEMPO

13 READ(UI,103)(ISTOR(K),STOR(K),K=1,4)
                                                                                                                00001980
                                                                                                                00001990
                                                                                                                00002000
                                                                                                               00002010
                                                                                                               00002020
                                                                                                              00002030
                                                                                                               00002040
                                                                                                               00002050
13 READ(UI,103)(ISTOR(K),510KIN),

DO 15 K=1,4

IF(ISTOR(K).NE.0)GO TO 16

15 CCNTINUE

GO TO 99

16 DO 20 K=1,4

I = ISTOR(K)

IF(I.LE.0)GO TO 20

IF(UD.GT.0)WRITE(UO,203)I,STOR(K)

TELL_GT_NMAX54)STOP 901
                                                                                                               00002060
                                                                                                               00002070
                                                                                                               00002080
                                                                                                               00002090
                                                                                                               00002100
                                                                                                               00002110
                                                                                                               00002120
                                                                                                               00002130
IF(UU.GI.U)WKIIELUU,205/1,5\UKIK,
IF(I.GT.NMAX54)STOP 901
I = NODIT(I)
IF(I.LE.O)STOP 901
T1(I) = STOR(K)
20 CCNTINUE
GO TO 13
99 WRITE(IOT)(T1(I), I=1, NODT)
                                                                                                               00002140
                                                                                                               00002150
                                                                                                               00002160
                                                                                                               00002170
                                                                                                             00002180
                                                                                                               00002190
                                                                                                               00002200
                                                                                                               00002210
100 CCNTINUE
                                                                                                               00002220
      RETURN
                                                                                                               00002230
      END
                                                                                                               00002240
      SUBROUTINE COMPW(UO, NOD, NODT, COORD, COORDT, NON, NOW, NODE, NODET)
                                                                                                               00002250
      SELECT THERMAL POINTS AND SET WEIGHTS FOR EACH STRUCTURAL NODE.
                                                                                                               00002260
      UO = OUTPUT FILE UNIT NUMBER.
                                                                                                               00002270
      NOD = NUMBER OF STRUCTURAL NODES.
                                                                                                               00002280
      NODT = NUMBER OF THERMAL NODES.
                                                                                                              00002290
      COORD(J,I) = JTH COORDINATE OF STRUCTURAL NODE I.
                                                                                                              00002300
```

```
COORDT(J, I) = JTH COORDINATE OF THERMAL NODE I.
C
                                                                                      00002310
       NCN(J,I) = JTH THERMAL NODE NUMBER (J=1-4) FOR STRUCTURAL NODE I. 0C002320
C
       NOW(J,I) = JTH THERMAL NODE WEIGHT (J=1-4) FOR STRUCTURAL NODE I. 00002330
C
       NODE(I) = EXTERNAL I.D. FOR STRUCTURAL NODE I.

NODET(I) = EXTERNAL I.D. FOR THERMAL NODE I.

INTEGER UC, NOD, NODT, NON(4,1), NODE(1), NODET(1)
C
                                                                                     00002340
                                                                                     00002350
                                                                                _ 00002360
       REAL COORD(3,1),COORDT(3,1),NOW(4,1)
                                                                                      00002370
       INTEGER INOD, I, J, I1, I2, I3, I4
                                                                                      00002380
       REAL C,R,W,W1,W2,W3,W4,P(3),P0(3),P1(3),P2(3),P3(3),P4(3),
                                                                                     00002390
      15(3),512(3),523(3)
                                                                                     00002400
  201 FORMAT(1H1,5H NODE,1X,4(4H PT,12),4(6X,2HWT,12))
                                                                                     00002410
  202 FORMAT(15,2X,4(15,1X),2X,4F10,4)
                                                                                     00002420
       IF(UO.GT.0)WRITE(UO,201)(J,J=1,4),(J,J=1,4)
                                                                                     00002430
       00 1000 INDD=1.NOD
    00 1000 INDD=1,NOD
DC 5 J=1,3
5 PO(J) = COORD(J,INOD)
                                                                                     00002440
                                                                                     00002450
 5 PO(J) = COORD(J,INOD)
LOCATE 1ST THERMAL PT AS NEAREST PT
R = 10.E30
00 500 I=1,NODT
DO 456 J=1,3
456 P(J) = COCRDT(J,I) - PO(J)
IF(P(1)**2+P(2)**2+P(3)**2.GE.R)GO TO 500
                                                                                     00002460
                                                                                     00002470
                                                                                     00002480
                                                                                     00002490
                                                                                     00002500 -
                                                                                     00002510
                                                                                     00002520
 R = P(1)**2+P(2)**2+P(3)**2

500 CONTINUE
    IF(R.EQ.O.)GO TO 951
    OO 512 J=1,3

512 PI(J) = CCORDT(J,II) + PO(J)
                                                                                     00002530
                                                                                     00002540
                                                                                     00002550
                                                                                     00002560
                                                                                     00002570
                                                                                     00002580
      LOCATE 2ND THERMAL PT AS NEAREST PT AT LEAST 90 DEGREES FROM 1ST 00002590
C
       R = 10.E30
                                                                                     00002600
       12 = 0
                                                                                     00002610
 DO 600 [=1,NODT
DO 556 J=1,3
556 P(J) = COGRDT(J,I) - PO(J)
                                                                                     00002620
                                                                                     00002630
                                                                                     00002640
      IF(P(1)**2+P(2)**2+P(3)**2.GE_R.OR.I.EQ.I1)GO TO 600
                                                                                     00002650
      IF(P(1)*P1(1)+P(2)*P1(2)+P(3)*P1(3).GT.0.)GO TO 600
                                                                                     00002660
      12 = 1
                                                                                     00002670
      R = P(1)**2+P(2)**2+P(3)**2
                                                                                     00002680
  600 CONTINUE
                                                                                     00002690
      IF(I2.EQ.0)GO TO 951
                                                                                     00002700
```

```
D0 612 J=1.3
                                                                           00002710
     P2(J) = COORDT(J, I2) - PO(J)
Si2(J) = P2(J) - P1(J)
                                                                           00002720
612 \text{ Si2}(J) = P2(J) - P1(J)
                                                                           00002730
    LOCATE 3RD THERMAL PT AS NEAREST PT FORMING ENCLOSING TRIANGLE
                                                                           00002740
    FOR PERPENDICULAR TO PLANE
                                                                           00002750
    R = 10.E30
                                                                           00002760
    I3 = 0
                                                                           00002770
    DO 700 I=1.NODT
                                                                           00002780
    DO 656 J=1.3
                                                                           00002790
656 P(J) = COGRDT(J,I) - PO(J)
                                                                           00002800
    IF(P(1)**2+P(2)**2+P(3)**2.GE.R.OR.I.EQ.II.OR.:I.EQ.L2)GO TO 7.00
                                                                           00002810
DO 662 J=1,3
662 S23(J) = P(J) - P2(J)
                                                                           00002820
                                                                           00002830
    S(1) = S12(2)*S23(3)-S12(3)*S23(2)

S(2) = S12(3)*S23(1)-S12(1)*S23(3)

S(3) = S12(1)*S23(2)-S12(2)*S23(1)
                                                                           00002840
                                                                           00002850
                                                                           C0002860
    IF(S(1).EQ.0..AND.S(2).EQ.0..AND.S(3).EQ.0.) GO TO 700
                                                                           00002870
    W1 = S(1)*(P2(2)*P(3)-P2(3)*P(2))+S(2)*(P2(3)*P(1)-P2(1)*P(3))
                                                                           00002880
   1+S(3)*(P2(1)*P(2)-P2(2)*P(1))
                                                                           00002890
    W2 = S(1)*(P(2)*P1(3)-P(3)*P1(2))+S(2)*(P(3)*P1(1)-P(1)*P1(3))
                                                                           00002900
   1+S(3)*(P(1)*P1(2)-P(2)*P1(1))
                                                                           00002910
    W3 = S(1)*(P1(2)*P2(3)-P1(3)*P2(2))+S(2)*(P1(3)*P2(1)-P1(1)*P2(3))00002920
   1+S(3)*(P1(1)*P2(2)-P1(2)*P2(1))
                                                                           00002930
    IF((W1:LE.O:.AND.W2.LE.O.:AND.W3.LE.O.);OR.
                                                                           00002940
   1(W1.GE.O..AND.W2.GE.O..AND.W3.GE.O.))GD TO 690
                                                                           00002950
    GO TO 700
                                                                           00002960
690 I3 = I
                                                                           00002970
    R = P(1)**2+P(2)**2+P(3)**2

CONTINUE

IF(13.EQ.C)GO TO 961
                                                                           00002980
700 CONTINUE
                                                                           00002990
                                                                           00003000
    DC 712 J=1.3
712 P3(J) = CCORDT(J, I3) - PO(J)
                                                                           00003010
                                                                           00003020
    LOCATE 4TH THERMAL PT AS NEAREST PT FORMING ENCLOSING TETRAHEDRON 00003030
    R = 10.E30
                                                                           00003040
    I4 = 0
    DO 800 I=1, NODT
                                                                           00003050
DO 756 J=1, NOU!
DO 756 J=1,3
756 P(J) = COCRDT(J,I) - PO(J)
                                                                           00003060 -
                                                                           00003070
                                                                           00003080
    IF(P(1)**2+P(2)**2+P(3)**2.GE.R.OR.I.EQ.I1.OR.I.EQ.I2.OR.I.EQ.I3) 00003090
   1GO TO 800
                                                                           00003100
```

```
W1 = P(1)*(P2(2)*P3(3)-P2(3)*P3(2))
                                                                           00003110
     1+P(2)*(P2(3)*P3(1)-P2(1)*P3(3))+P(3)*(P2(1)*P3(2)-P2(2)*P3(1))
                                                                           00003120
      W2 = -P1(1)*(P3(2)*P(3)-P3(3)*P(2))
                                                                           00003130
     1-P1(2)*(P3(3)*P(1)-P3(1)*P(3))-P1(3)*(P3(1)*P(2)-P3(2)*P(1))
                                                                           00003140
      W3 = P2(1)*(P(2)*P1(3)-P(3)*P1(2))
                                                                           00003150
     1+P2(2)*(P(3)*P1(1)-P(1)*P1(3))+P2(3)*(P(1)*P1(2)-P(2)*P1(1))
                                                                           00003160
      W4 = -P3(1)*(P1(2)*P2(3)-P1(3)*P2(2))
                                                                           C0003170
     1-P3(2)*(P1(3)*P2(1)-P1(1)*P2(3))-P3(3)*(P1(1)*P2(2)-P1(2)*P2(1))
                                                                           00003180
      IF((W1.LE.O..AND.W2.LE.O..AND.W3.LE.O..AND.W4.LE.O.).OR.
                                                                           00003190
     1(W1.GE.O..AND.W2.GE.O..AND.W3.GE.O..AND.W4.GE.O.))GO TO 790
                                                                           00003200
      GO TO 800
                                                                           00003210
  790 I4 = I
                                                                           00003220
      R = P(1)**2+P(2)**2+P(3)**2
                                                                           00003230
  800 CONTINUE
                                                                          00003240
      IF(I4.EQ.0)GD TO 971
                                                                          00003250
      00 812 J=1.3
                                                                          00003260
  812 P4(J) = CCORDT(J, I4) - PO(J)
                                                                          00003270
      4 THERMAL PTS CAN BE USED
                                                                          00003280
      W1 = P4(1)*(P2(2)*P3(3)-P2(3)*P3(2))
                                                                          00003290
     1+P4(2)*(P2(3)*P3(1)-P2(1)*P3(3))+P4(3)*(P2(1)*P3(2)-P2(2)*P3(1))
                                                                          00003300
      W2 = -P1(1)*(P3(2)*P4(3)-P3(3)*P4(2))
                                                                          00003310
     1-P1(2)*(P3(3)*P4(1)-P3(1)*P4(3))-P1(3)*(P3(1)*P4(2)-P3(2)*P4(1))
                                                                          00003320
      W3 = P2(1)*(P4(2)*P1(3)-P4(3)*P1(2))
                                                                          00003330
     1+P2(2)*(P4(3)*P1(1)-P4(1)*P1(3))+P2(3)*(P4(1)*P1(2)-P4(2)*P1(1))
                                                                          00003340
      W4 = -P3(1)*(P1(2)*P2(3)-P1(3)*P2(2))
                                                                          00003350
     1-P3{2}*(P1(3)*P2(1)-P1(1)*P2(3))-P3(3)*(P1(1)*P2(2)-P1(2)*P2(1))
                                                                          00003360
      W = W1 \pm W2 + W3 + W4
                                                                          00003370
      IF(W.EQ.O.)GO TO 971
                                                                          00003380
      WI = WI/W
                                                                          00003390
      W2 = W2/W
                                                                          00003400
      W3 = W3/W
                                                                          00003410
      W4 = W4/W
                                                                          00003420
      GO TO 991
                                                                          00003430
      ONLY 1 THERMAL PT CAN BE USED
С
                                                                          00003440
  951 I2 = I1
                                                                          00003450
      I3 = I1
                                                                          00003460
      I4 = I1
                                                                          00003470
      W1 = 1.0
                                                                          00003480
      W2 = 0.
                                                                          00003490
      W3 = 0.
                                                                          00003500
```

```
W4 = 0.
                                                                          00003510
    GC TO 991
                                                                          00003520
    ONLY 2 THERMAL PTS CAN BE USED
                                                                          00003530
961 I3 = I1
                                                                          00003540
    14 = 11
                                                                          00003550
    W3 = 0.
                                                                          00003560
    W4 = 0.
                                                                          00003570
    W = 0
                                                                          C0003580
    R = 0
                                                                          00003590
    DO 965 J=1.3
                                                                          00003600
    W = W + P2(J)*(P2(J)-P1(J))
                                                                          00003610
965 R = R + (P2(J)-P1(J))**2
                                                                          00003620
    IF(R.EQ.O.)GO TO 951
                                                                          00003630
    WI = W/R
                                                                          00003640
    W2 = 1.0 - h1
                                                                          00003650
    GO TO 991
                                                                          00003660
    ONLY 3 THERMAL PTS CAN BE USED
                                                                          00003670
971 I4 = I1
                                                                          00003680
    W4 = 0.
                                                                          00003690
    DO 975 J=1.3
                                                                          00003700.
975 S23(J) = P3(J) - P2(J)
                                                                          00003710
    S(1) = S12(2)*S23(3)-S12(3)*S23(2)

S(2) = S12(3)*S23(1)-S12(1)*S23(3)

S(3) = S12(1)*S23(2)-S12(2)*S23(1)
                                                                          00003720
                                                                          00003730
    S(3) = S12(1)*S23(2)-S12(2)*S23(1)
                                                                          00003740
  · IF(S(1).EQ.O..AND.S(2).EQ.O..AND.S(3).EQ.O.) GO TO 961
                                                                          00003750
    WI = S(1)*(P2(2)*P3(3)-P2(3)*P3(2))+S(2)*(P2(3)*P3(1)-P2(1)*P3(3))00003760
   1+S(3)*(P2(1)*P3(2)-P2(2)*P3(1))
                                                                          00003770
    W2 = S(1)*(P3(2)*P1(3)-P3(3)*P1(2))+S(2)*(P3(3)*P1(1)-P3(1)*P1(3))00003780
   1+S(3)*(P3(1)*P1(2)-P3(2)*P1(1))
                                                                          00003790
    W3 = S(1)*(P1(2)*P2(3)-P1(3)*P2(2))+S(2)*(P1(3)*P2(1)-P1(1)*P2(3))00003800
   1+S(3)*(P1(1)*P2(2)-P1(2)*P2(1))
                                                                          00003810
    W = W1 + W2 + W3
                                                                          00003820
    IF(W.EO.O.)GO TO 961
                                                                          00003830
    W1 = h1/W
                                                                          00003840
    W2 = W2/W
                                                                          00003850
    W3 = W3/W
                                                                          00003860
991 \text{ NCN(1,INOD)} = I1
                                                                         00003870
    NON(2,INOD) = I2
                                                                         00003880
    NON(3, INOE) = 13
                                                                         00003890
    NCN(4,INOE) = 14
                                                                         00003900
```

```
NOW(1.INOD) = W1
                                                                                    00003910
       NCW(2,INOC) = W2
                                                                                    00003920
       NCW(3 \cdot INOC) = W3
                                                                                    00003930
       NOW(4.INOC) = W4
                                                                                    00003940
       1F(UO.GT.O)WRITE(UO.202)NODE(INOD),NODET(I1),NODET(I2),NODET(I3), 00003950
      INCDET(I4), W1, W2, W3, W4
                                                                                    00003960
 1000 CONTINUE
                                                                                    00003970
       RETURN
                                                                                    00003980
       END
                                                                                    00003990
       SUBROUTINE TCOMP(UI, UO1, UO2, IOT, NOD, NODT, NON, NOW, NTIME, TIME, NODE) C0004000
C
      COMPUTE AND OUTPUT STRUCTURAL NODE TEMPERATURES AT GIVEN TIMES.
                                                                                    00004010
C
       UI, UO1, UO2 = INPUT, OUTPUT FILE UNIT NUMBERS.
                                                                                    00004020
       IOT = FILE UNIT NUMBER FOR THERMAL NODE TIME-TEMPERATURE VECTORS. 0C004030
C
C
       NOD = NUMBER OF STRUCTURAL NODES.
                                                                                    00004040
       NODT = NUMBER OF THERMAL NODES.
                                                                                    00004050
Ç
      NON(J,I) = JTH THERMAL NODE NUMBER (J=1-4) FOR STRUCTURAL NODE I. 00004060
      NOW(J.I) = JTH THERMAL NODE WEIGHT (J=1-4) FOR STRUCTURAL NODE I. 00004070
      NTIME = NUMBER OF TIME VALUES FOR THERMAL NODES:
                                                                                    00004080
C
      TIME(I) = ITH TIME VALUE FOR THERMAL NODES.
                                                                                    00004090
C
      NCDE(I) = EXTERNAL I.D. FOR STRUCTURAL NODE I.
                                                                                    00004100
      STOP 1001 = STRUCTURAL TIME IS OUTSIDE RANGE OF THERMAL TIMES. OR 00004110
C
      TIMES ARE NOT IN INCREASING ORDER.
                                                                                    00004120
      COMMON/COMTO/TO/COMT1/T1
                                                                                    00004130
C
      TC(I), T1(I) = TEMPERATURES OF ITH THERMAL NODE AT TIMES 0.1.
                                                                                    00004140
      INTEGER UI, UO1, UO2, IOT, NOD, NODT, NON(4,1), NTIME, NODE(1)
                                                                                    00004150
 REAL NOW(4,1),TIME(1),TO(1),TI(1)
INTEGER I,J,K,L,II,ISTOP,IT,ISTOR(4)
REAL STIME,C,W,TIMO,TIM1,FO,F1,STOR(4)
101 FCRMAT(F10.0,110)
201 FCRMAT(F10.4,70(1H*))
202 FCRMAT(4(I10.F10.2))
      REAL NOW (4,1), TIME(1), TO(1), T1(1)
                                                                                    00004160
                                                                                    00004170
                                                                                    00004180
     FURMAT(F1014,70(1H*))
FORMAT(4(110,F10.2))
FORMAT(1H )
FORMAT(1H1)
IF(U01.GT.0)WRITE(U01,205)
REWIND IOT
IT = 2
PEAD(IOT)(T1(I),I=1,NODT)
                                                                                    00004190
                                                                                    00004200
  202 FORMAT(4(I10.F10.2))
                                                                                    00004210
  203 FORMAT(1H )
                                                                                    00004220
  205 FORMAT(1H1)
                                                                                    00004230
                                                                                    00004240
                                                                                    00004250
                                                                                    00004260
                                                                                    00004270
```

00004280

```
2 \text{ TO } (I) = T1(I)
                                                                                00004290
    READ(IOT)(TI(1),1=1,100...
READ(UI,101)STIME,ISTOP
IF(ISTOP.NE.O)GO TO 501
IF(U01.GT.O)WRITE(U01,201)STIME
ON WRITE(U02,201)STIME
                                                                                00004300
  1 REAC(UI, 101)STIME, ISTOP
                                                                                00004310
                                                                                00004320
                                                                                00004330
                                                                                00004340
     IF(STIME.LT.TIME(IT-1))STOP 1001
                                                                                00004350
  3 IF(STIME.LE.TIME(IT))GO TO 9
                                                                                00004360
     IT = IT + I
                                                                                00004370
     IF(LT.GT.NTIME)STOP 1001
                                                                                00004380
     D0 6 I=1.NODT
                                                                                00004390
  6 TO(I) = TI(I)
                                                                                00004400
    READ(IOT) (T1(I), I=1, NODT)
                                                                                00004410
    GC TO 3
                                                                                00004420
  9 \text{ TIMO} = \text{TIME}(IT-1)
                                                                                00004430
    TIMI = TIME(IT)
                                                                               00004440
    FO = TIM1-TIM0
                                                                               00004450
    1F(F0.GT.0.)F0 = (TIM1-STIME)/F0
                                                                               00004460
    F1 = 1.0 - F0
                                                                               00004470
    I = 0
                                                                               00004480
 11 L = 0
                                                                               00004490
    DO 20 K=1,4
                                                                               00004500
    I = I+1
                                                                               00004510
    IF(I.GT.NOD)GO TO 20
                                                                               00004520
    L = L+1
                                                                               00004530
    ISTOR(L) = NODE(I)
                                                                             00004540
    C = 0
                                                                               00004550
    00 \ 15 \ J=1.4
                                                                               00004560
    II = NON(J, I)
                                                                               00004570
    W = NOW(J.I)
                                                                               00004580
 15 C = C + W*(F0*T0(II)+F1*T1(II))
                                                                               00004590
    STOR(L) = C
                                                                               00004600
 20 CONTINUE .
                                                                               00004610
    IF(L.NELO)GO TO 51
                                                                               00004620
    IF(UC1.GT.0)WRITE(UO1,203)
                                                                               00004630
    IF(U02.GT.0) WRITE(U02,203)
                                                                               00004640
    GO TO 1
                                                                               00004650
 51 IF(UO1.GT.0)WRITE(UO1,202)(ISTOR(K),STOR(K),K=1,L)
                                                                               00004660
    IF(UO2.GT.O) WRITE(UO2,202)(ISTOR(K),STOR(K),K=1,L)
                                                                               00004670
    GO TO 11
                                                                               00004680
501 RETURN
                                                                               00004690
    END
                                                                               00004700
```